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ABSTRACT

Two questions--how school boards might create more productive schools using the tools of the electronic age, and how they might create new learning opportunities and overcome some of the problems schools now face--were addressed at the national conference summarized in this document. The report reviews the current status of public education today and previews where it may be tomorrow once school boards use new technological tools to lead the nation's schools. The problems caused by the uncertain and rapid changes in technology, are briefly discussed in the introduction. The first of three sections then discusses applications of technology to the problems of education in the context of economic, demographic, employment, and educational trends. The magnitude of technological change and the future of education as it is linked to economic growth are also considered. Current uses of technology in schools for educational and administrative purposes are reviewed in the second part, including descriptions of specific educational technology projects. The third section presents practical suggestions for adopting appropriate policies, purchasing hardware, evaluating software, encouraging teachers, and locating the funds needed to implement a technology plan. A glossary of technological terms, a directory of resource persons for schooling and technology, and facts about the National School Boards Association (NSBA) conclude the report. (DJR)

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NEW TECHNOLOGIES:

KEY TO MORE PRODUCTIVE SCHOOLS

NSBA
NATIONAL SCHOOL BOARDS ASSOCIATION

NEW TECHNOLOGIES: KEY TO MORE PRODUCTIVE SCHOOLS

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High tech production was an integral—and appropriate—component to the final printing of New Technologies: Key to More Productive Schools. The manuscript was produced on site at Houston's Infomart with two IBM PCs and a Wordstar software package. All of the text, which required space on just two discs, was then edited by computer at NSBA offices in Alexandria, Virginia, and sent via modem to the typesetter for processing. Graphic artwork was produced entirely by a student, 12-year-old Charlie Berger of Frederick, Maryland, on a Macintosh 512K computer (using the MacPaint software package) and printed on an Apple Imagewriter. Charlie also participated in the cover design, again using the Macintosh.

FOREWORD

How might school boards create more productive schools using wisely the tools of the electronic age? How might school boards create new learning opportunities and overcome some of the problems schools now face?

The challenge is "an educational Mt. Everest," according to Houston school superintendent Billy Reagan. The potential rewards loom as large.

This report, New Technologies: Key to More Productive Schools, does not question whether the new technologies are school board business. Decisions about the tools of education always have been school board business. The report, instead, reviews where public education stands today and previews where it may be tomorrow once school boards use these new technological tools to lead the nation's schools there.

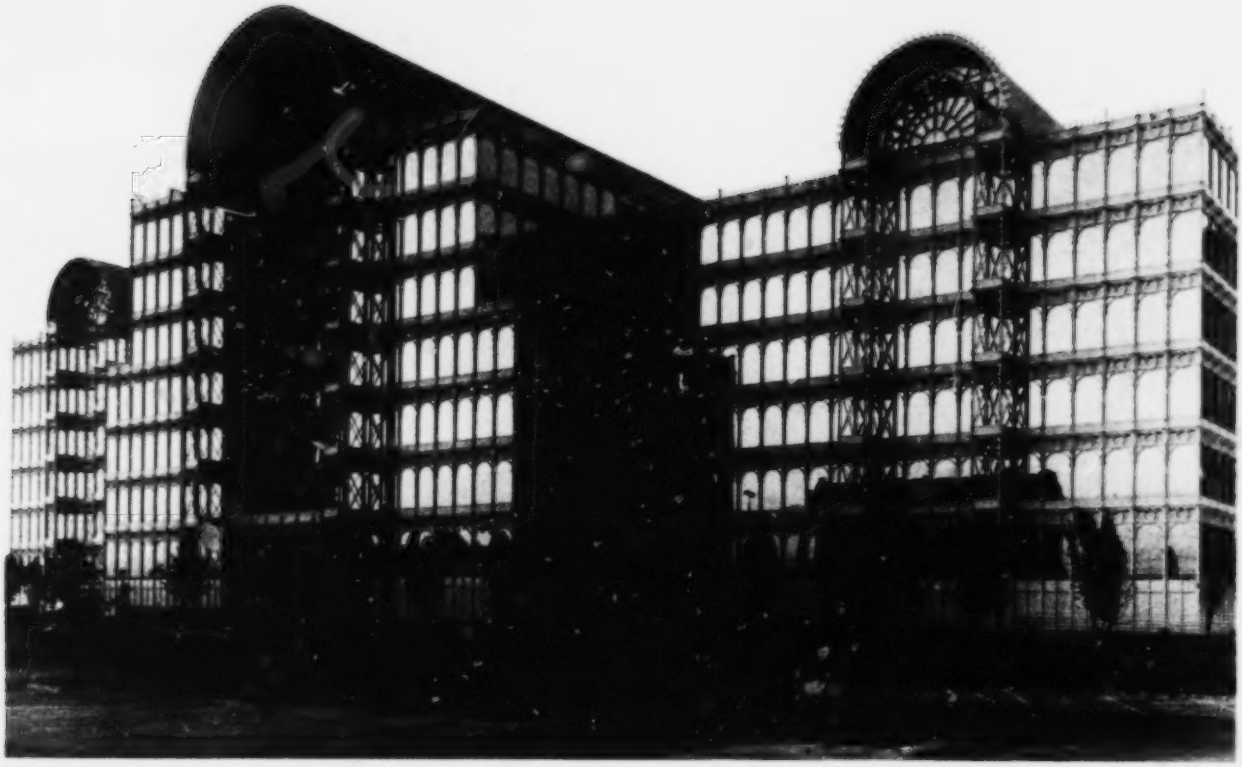
Fulfilling this hope and expectation requires collaboration. Local, state and national government leaders, universities, creators and vendors of technology, educators and public school leaders need each other. With that idea in mind, the NSBA Board of Directors established this year a new program to aid state school boards associations and local school districts in exploring productive uses of the powerful new technological tools now at their disposal.

Among its first activities, the NSBA Institute for the Transfer of Technology to Education (ITTE) sponsored a first annual national conference in Dallas, August 1-3, 1985, hosted by INFOMART. The list of co-sponsors of INDEX: EDUCATION: Computers, Technology and Learning reflects precisely the kind of collaboration that will help school leaders nationwide succeed in future ventures:

- The National School Boards Association Institute for the Transfer of Technology to Education
- The American Library Association, Library and Information Technology Association
- Southern Methodist University Edwin L. Cox School of Business
- The American Society for Training and Development, Dallas Chapter
- The Texas Computer Education Association

This report, which grows out of the first annual INDEX: EDUCATION conference, is dedicated to advancing public education in America because NSBA and its Federation Members—the state school boards associations—believe that the nation's schools should exploit the best teaching/learning resources in the nation. Technology is such a resource.

Thomas A. Shannon
Executive Director



INFOMART, the setting for the meeting, is architecturally splendid. The brainchild of real estate developer Trammell Crow, INFOMART is a dazzling rendition of Victorian England's Crystal Palace, built in 1851 to house the Great Exhibition of All Nations. That structure, which ushered in the Industrial Revolution, seemed an apt model to Crow for his building which displays the wares of the new Computer Revolution.

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The promise of a more productive future for schools is no further away than the nearest silicon chip, as 1,500 educators learned during three days in the heart of Texas.

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In Memoriam: Paul A. Salmon

INTRODUCTION

Take a few moments, if you will, and step with us into the future. We don't have far to go, just to Dallas, as did 1,500 educators during August 1-3, 1985. This report is gleaned from that unique meeting, written for all who could not be there.

Vying for Texas' share of the world's burgeoning high-technology business, parts of Texas are on the fast track to rivaling California's Silicon Valley or Louisiana's Silicon Bayou. The catchy moniker "Silicon Prairie" has been suggested for the Dallas area, which sprawls only a short distance from the National Aeronautics and Space Administration, the multimillion-dollar robotics institute at the University of Texas at Arlington, the biotechnology center in San Antonio, and an abundance of microelectronic product manufacturing companies.

Appropriately, in the midst of this technological oasis stands the world's first international trade center devoted exclusively to information processing products and services. INFOMART—an acronym for International Information Processing Market Center—is a place where anyone can explore and learn about the latest hardware, software, and uses of technology by visiting permanent showrooms maintained by many of the world's information processing companies.

The most comprehensive collection of state-of-the-art technology ever assembled under one roof, INFOMART—with eight floors and 1.5 million square feet of exhibit and conference space—has this as an objective: to help consumers identify their problems and to help them find the appropriate technology to address their needs and solve their problems.

This dedication to consumer education, rather than to product-specific sales, makes INFOMART the perfect host for an annual meeting sponsored by NSBA's Institute for the Transfer of Technology to Education. The first of these annual events, dubbed INDEX: EDUCATION—Computers, Technology and Learning, drew more than 1,500 educators from 30 states and four countries. The term "EDUCATION" is broadly construed at INFOMART to include not only public school educators, but leaders and professionals in universities, libraries and training, as well. Accordingly, INDEX: EDUCATION was co-sponsored by organizations in those communities. Participants not only addressed the dilemmas of their professions but also solutions available now or being developed for tomorrow.

CHANGE-MAKERS

Most INDEX: EDUCATION participants were educators and policy makers convinced that electronic technology holds promise for the future of education, although its ultimate shape is shadowy at best. Vexed by the plethora of incompatible computer hardware and software available for school settings today, many came to Dallas hoping to reduce their uncertainty about technology's precise applications within the teaching and learning process.

Keynote speaker Richard Byrne offered some comfort to these participants, whom he called "self-selected change-makers." Said Byrne: "You're here in Dallas in the heat of August because you know that technology holds promise for solving school problems. But you're anxious in this age of unprecedented uncertainty about how to accomplish your goals."

Continuing, Byrne told his audience of public school leaders and educators, university professionals, librarians and corporate trainers, "You are all in the learning business, all in the education business, all facing the same problem and the

same opportunities afforded by this 'unprecedented uncertainty.' You need to work together. You need each other."

Such uncertainty is understandable. Today's technology is changing so fast that even its producers cannot be certain that the fantastic new widget they invent Monday night will still be the latest marvel on the market when they arrive at work Tuesday morning. For most educators—who may not know which computers to buy, what is compatible with what, whether to sell what they've got, which software does what—uncertainty is a natural state.

But uncertainty should not result in paralysis, Byrne told attendees, contrasting their incertitude with doubt or disbelief. He spoke of the doubters and disbelievers—those people who believe that the personal computer revolution was just a blip on the screen of history, a hump on the chart of progress, or something that came but now is over. These individuals are misled in the short run, he believes, by headlines that announce Apple's reorganization or the withdrawal of the IBM PCjr from the marketplace.

"In fact data processing budgets are up 7.8 percent all over the world, and so too is computer acquisition. Technology is here to stay," declared Byrne, "even if for the moment there are those out there who take comfort in believing the computer revolution never happened."

For the visionaries, the change-makers and the doubters, this report presents the collective wisdom of INDEX: EDUCATION participants on the challenges and potential rewards of technology in education.

The report balances dreams of the future with practical tips—all with the aim of making schools more productive. Throughout you'll find the caveat of even the most optimistic "techies"—computer fanatics. For all their power, technological tools are only tools, not a panacea. Like any tool, new technologies must be applied conscientiously and with a plan for long-term results.

PART I:

TECHNOLOGY'S PROMISE

Speakers at INDEX: EDUCATION cited the possibilities of tomorrow to evoke visions of the life mankind will create with new technologies—the context for education in the future. Some extraordinary images were produced:

- Sitting in an instrumentless cockpit, a pilot verbally commands the plane to bank left. It does.
- Robots exploring planets, programmed to act on their own in case of peril, since guidance by radio from earth would take too long.
- Factories in space outproducing factories on earth because there's no friction to wear out machine parts.
- Plants and animals growing with a quarter of the food and water they require today, but under better conditions and with no loss in nutritional value.
- Humans working comfortably for weeks on end in such inhospitable environments as deserts, space and the undersea world.

The possibilities for education are no less exciting:

- In a classroom, Marie chooses two test tubes from a rack, pours the contents into a beaker, and slowly heats the mixture over a Bunsen burner. As the instructions indicate, a precipitate forms. Just for fun, she tries the experiment again, but with the flame turned as high as it will go. Smoke rises and the mixture—poof!—disappears. Throughout the day, 200 more students do the same experiments or their own variations. Yet, when the dismissal bell rings, not one dollar has been spent on chemicals and there is no mess to clean up. Why? A computer simulated the entire experience again and again for each student.

Farfetched? Not really. These visions are just a step or two beyond the technology now available. Today, aircraft designers use computer graphics to build experimental planes and put them through practice tests—without ever having to go to the cost of building wind tunnels or risking human life. Robots in San Francisco remove explosives for the police department. With a portable computer system, a young girl's paralyzed legs now walk.

The future of schools as well as teaching and learning also lies just a step or two beyond today's technology. Educators and policymakers can, and will, take those steps—partly because they choose to, but partly because changes in the greater society can be counted upon to reshape schooling.

CHANGING TIMES, CHANGING SCHOOLS

Changing times and external trends often influence schools far more than anything the most able educator has ever planned. Witness the sudden emphasis on school science and mathematics when the Soviet Union launched the first Sputnik satellite. Witness public school integration and the birth of equal access to educational opportunities, both by-products of the civil rights movements.

Futurist Chris Dede and a number of speakers at INDEX: EDUCATION pointed to powerful external forces that are shaping and will shape education:

Economic Trends

As the United States has grown, schools' revenue has grown. But the prospect for long-term economic growth is not rosy. The apparent economic recovery the nation is enjoying may well be only a

BEWARE MRS. WHITE'S CLOSET

Even as one can believe with Albert Einstein that, "Computers are incredibly fast, accurate and stupid; humans are incredibly slow, inaccurate and brilliant; together they are powerful beyond imagination," one laughs uneasily with Houston's school superintendent Billy Reagan:

"Twenty-eight years ago, as a 5th grade teacher, Mrs. White in the classroom next door kept all the globes and maps in her closet. Since then we've had phonographs, tape recorders and television come into the schools. They're all on Mrs. White's shelves gathering dust."

Putting gadgets into schools without a plan for their educational application guarantees that they'll never be used, according to Reagan, whose district has an international reputation for leadership in transferring technology into schools. Houston's plan includes having placed a technology missionary into every school building—"teacher technologists" who earn that title only after 300 clock hours of training in applying existing hardware and software to school problems.

slight upturn in a long downward spiral. Supporting this cautionary note about the economy's growth are the following data:

- Seven million people currently are unemployed.
- The federal deficit today could only be paid off if each family of four were to contribute $11,800. By 1990, it will require $2,300 annually from each household just to pay the interest on the nearly $3 trillion national debt. "We're borrowing more in one year than the second largest debtor nation in the world owes totally," Dede noted.
- The society is short on investment capital, hampering innovation and the opportunity for bold new directions in research and development. As interest rates remain above the rate of inflation, the nation's resources are turned to paying its own debt. It's sobering to look at other nations which, like the U.S., have been borrowing so heavily for 30 years that today many appear unable to pay off even the interest, much less the principal, on those debts.
- Linked to foreign economies through an international balance of payments system, the American economy is vulnerable. If any nation defaults on its debts, all others necessarily are affected. Admiral Bobby Inman told conferees that the international system can sustain one default but two major ones would do in the system. Said Inman ominously, "A default could be triggered by something as small as a drop in the price of oil by $2 or by a two percent rise in interest rates."
- Finally, discretionary income—those dollars available after essentials—has steadily decreased. The flush period Americans enjoyed in the 1950s, '60s and '70s is gone, with discretionary income levels now at the same level as in 1969.

"There is no easy way to go back to the prosperity of the 1960s," said futurist Chris Dede, who believes that the U.S. is moving into a new kind of economy, one with global dimensions. Long past is the burst in growth the nation experienced after World War II when our geared-up factories faced no competition from bombed-out Europe or the Far East, and energy, labor and materials all were cheap. Now everything is expensive, interest rates are up, America's factories are obsolete, and our population growth rate is down. Accompanying the economic pressures growing out of this situation will be an onus upon schools to increase productivity without increasing costs.

Demographic Trends

Another impetus for educational change lies in current and forecasted demographic shifts in America—changes that are placing new demands and strains on traditional institutions. There are now more two-income families, higher divorce rates, and increasing numbers of single parent families. By 1990, an estimated one-half of all children will live with single parents.

Also, the racial/ethnic composition of our society is changing. Population specialists estimate more than 50 percent of the population will be non-Caucasian by the mid-1990s due to greater birth rates among minority races.

Such trends have major implications for education. One, single and working parents will need and want quality preschool programs for their younger children as well as daycare services for all their children. Two, assuring educational equity—a major premise underlying American education—will require schools to implement increasingly diverse and sometimes controversial classroom programs, such as bilingual or multicultural education. Three, as the drive for "excellence" in teaching and learning continues, additional barriers to high school completion may be raised by increased academic standards for those students already at risk, exacerbating already high dropout rates in our schools.

Nowhere is the impact of changing demographics trends more pronounced than in major urban areas. Speaking for Houston and other urban centers across the country, the city's superintendent of schools, Billy Reagan, illustrated the complexity of the problems facing these schools: "We represent 25-30 percent of all the children in public schools. Let me point out why we here in Houston so desperately need ways to deal with the diversity in the urban area."

"In Houston, 85 percent of our kids are minorities, 75 percent have two working parents, 40 percent live with single parents, 35,000 speak no English at all and another 55,000 need help with English, 45 percent qualify for free and reduced price lunches, 25,000 are in special education, and 42 percent of our students move at least once between September and June in every school year."

Rate of Change

The rate at which economic, political and demographic events whirl around us is stressful at best, possibly immobilizing, sometimes volatile. The sheer amount of information to be absorbed within a short period of time grows too fast for comprehension. Yet most schools continue to operate with the same 12-year format of 175 six-hour days of an earlier era.

AFRAID OF COMPUTERS?

"Everything I talk about is easy to do: the big thing is to get people to accept it. The best way to do that is for the boss to tell the less senior staff that the old way of doing things will no longer be done, put a computer in the office—along with a trainer—close the door, and walk away." Sam Zigossi, IBM trainer of computer-phobic executives.

"Educators are about as cautious about new technology as an Indian elephant. The elephant, coming to a bridge, will not step right out to cross it. First, he tests it with his trunk. If it feels firm, he plants his front feet on it. If it holds, he moves over and sits on the edge of it. If that proves solid, then he sends across another elephant." Linus Wright, Dallas school superintendent.

"Teachers fear that computers either will replace them or make fools out of them in front of their students." Gordon Stulberg, Polygram Corporation president.

This geometric growth in knowledge—and the everchanging nature of that knowledge—implies a need for schools to use instructional time more effectively so that students are adequately prepared for the future. Demonstrably effective teaching practices and learning procedures will have to supplant less-successful methods because today's society and the workplace place a new premium on schools graduating students who possess critical thinking, analytical and problem-solving skills. Such improved teacher and student productivity may come in the form of curriculum changes or through different teaching and learning strategies.

Within this framework, computers and other electronic tools--with their amazing ability to help the human brain compute, sort and function many times faster—offer a glimmer of hope for renewed teaching and learning. One caution: Computers have no virtue in themselves; they gain value only if they do in fact aid teaching and learning.

The rate of information change also reduces what Dede calls "occupational half-life"—the length of time one's knowledge is useful in one's work before obsolescence sets in. One generation ago, the skills and knowledge that a person learned in school assured him of a job, without retraining, for as long as 15 years. Now, a person must re-educate himself every five years to update his current career skills. Such rapid obsolescence of learning presents both opportunities and problems for the schools.

Employment Trends

As Americans use electronic tools more and more in schools, offices, factories and at home, the entire nature of the U.S. job market is changing. New products, jobs and industries are being created; existing ones are being modernized and made more efficient. Automated workplaces reduce the number of unskilled jobs available; but they also raise the demand for skilled workers in the service industries which support automation.

Illustrative of the impact of a changing job market on education is a study of the labor force in Japan, a country which epitomizes technological efficiency. The study predicted that by 1990, between 200,000 and 500,000 factory jobs will be lost, but that 700,000 more will be created by the service industries. "The future," said Admiral Bobby Inman referring to the Japanese study, "will need not only more scientists and engineers, but also people trained in business for their marketing and management skills, and liberal arts graduates for their people skills, language and cultural studies, and other area studies."

All of this challenges schools' expectations of what students need to know at graduation; and it challenges the traditional school curriculum.

Education Trends

"Of course public schools are expected to sort all of this out, but they cannot possibly do it alone," stated Dede. "In the past decade we have seen other groups that used to take responsibility for raising children systematically dump their responsibility on the schools. And then they have turned around, banded together and written a series of 'excellence' reports on why the schools have failed."

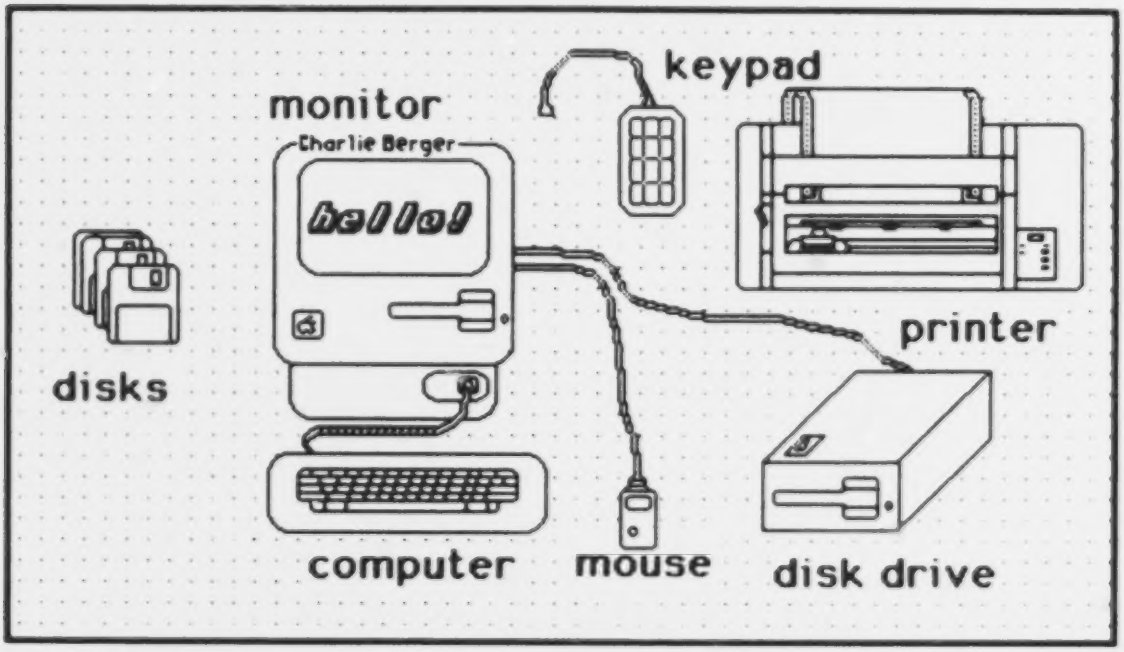
Educators have some right to be miffed at these harsh reports, according to Dede, which unfairly ask, in effect, why schools singlehandedly cannot deal with an economic situation that deters many bright, talented young people from pursuing low-paying teaching careers; why schools cannot train and retrain everyone to cope with the awesome changes in the job market; and why schools cannot serve the overwhelming diversity of individual needs.

Yet, educators have not yet, for the most part, faced up to the public's expectations for major change posed by these "excellence" reports; and they **cannot**, concede many educational researchers, if schools persist in their current traditional instructional mode.

THE MAGNITUDE OF TECHNOLOGICAL CHANGE

If technology has not already changed the nature of public schooling, it soon will as computers, software and other systems rapidly grow more powerful, available and accepted.

"In 37 years in the education business, I've



been through it all," said Linus Wright, superintendent of the Dallas school system. Having seen at least 25 innovations move into and out of the schools, he avows that "computer technology is here to stay—this is not just another phase. The changes that the computer will bring to mankind are as profound as what happened after the invention of the printing press."

Richard Byrne agreed. "Technological change is not like the familiar changing of the seasons, where we know fall is coming, so we open the closet and take our woolens out of mothballs. With electronic technology, we are experiencing 'second order change,' wherein something happens, mankind takes a quantum leap and nothing is ever the same again."

Technologically, the trends are toward ever smaller, cheaper, more capable systems. Thus, the impact of these trends will help make technology even more commonplace at home, at work, in entertainment and in learning.

More Processing Power

Since World War II, when the first computers appeared on the scene, filling a room the size of an auditorium, our ability to process information faster has doubled every two years with no increase in cost. Today, a desktop personal computer works 20 times faster and costs 200 times less than those first computers. Within 10 years, some analysts believe there will be computers the size of a thumbnail, able to work 10 or even 100 times faster than today's desktop personal computers. Yet others maintain that our ability to process information will approach the speed of light by the mid-1990s.

Larger Storage Capacity

Today, a videodisc the size of a phonograph record, which costs only $10 to manufacture, can store 54,000 screens of information—the equivalent of hundreds of books' worth of words or pictures. An optical compact disc, with the capacity to

SCHOOLS AT WATERSHED

"To be sure, there are skeptics who think that schools are like the railroads, unable to become airlines despite the new technology," stated James A. Mecklenburger, director of NSBA's Institute for the Transfer of Technology to Education. Technology, he believes, however, is school boards' lever to render change on a large scale, for schools to evolve from railroads to airlines during the rest of this century. "It just takes a vision of what's possible and the will to move ahead."

So far, most school boards have been trapped by a limited view of technology—dressing up the railroad, not yet building the planes. They've added a lot of "small boxes" to their classrooms, stand-alone computers with limited ability. "There are probably one million such computers in schools today—not as many as chalkboards, but lots," said Mecklenburger, "so it's not surprising that when people today think of technology in the school, their mind's eye only sees those little boxes supplementing instruction in interesting, but for the most part, little ways. "His forecast: "We will see—within 20 years—today's "small box" view of technology diminish and an array of technologies assume important roles in schools."

A look at education 20 years ago can put today's education problems in perspective. The search for "excellence" is hardly new. Educators tried to embrace the idea of individualized education in the 1960s, to create plans that would allow every child to learn what he is best at learning, at a pace best suited to his abilities.

"We knew then that learning is done by ones, even if teaching occurs in groups. All the innovations of the 1960s—individualized education, open classrooms, schools without walls—had merit," Mecklenburger said, "but educators could not sustain them because the technology did not exist to enable educators to succeed."

"Think of all the record keeping individualized instruction takes. What way was there for a single teacher to track every individual student's progress toward mastery of, say, 1,000 learning objectives? The central office of even the smallest school district in 1965 could not hope to track the progress of every student in every single classroom."

Twenty years later, this is possible. The required technology is less complicated than that used daily by the airline industry to book reservations, or by banks to track funds entering and leaving through branch offices and automated tellers.

Predicted Mecklenburger: "Future historians will look back to 1985 as a watershed year in public education. "Some few successful applications of technology in schools today (see Part III) are the dawn of this bright tomorrow. Further, a national interest in applying technology to education is manifest in the appointment by the U. S. Secretary of Education of the Secretary's Task Force on Technology and Education, whose 15-year blueprint for action is due out by the end of 1985.

store 1,000 times more information than today's magnetic floppy discs, yet which costs only $3 to manufacture, is on the market. To put that capacity in perspective: one optical disc can store five complete sets of a major encyclopedia, or the name, address, and phone number of every person in every city in the United States.

In Japan, researchers are developing a storage chip for filmless cameras that will store 50-60 pictures, and insert into a television set for viewing. Also coming: a magnetic bubble that, encased in a device the size of a shoe box, would be able to store the entire holdings of the Library of Congress.

Faster Transmission Capacities

Optical fibers, cheaper than the old copper wires and in endless supply (they're made from sand), can carry data at speeds equivalent to 10 books per second—close to the speed of light. Satellite dishes can receive almost countless transmissions from almost anywhere in the world, and cable television capacities are reaching the point where subscribers will be able to tune into their choice of 1,600 television shows at any hour of the day.

Increased "Artificial" Intelligence

Add to all these incredible advances the prospect of computers making some value judgments about which data are important to process, store, or transmit and one foresees the dawn of "artificial intelligence."

"Artificial intelligence is not an attempt to reduce the capabilities of the human brain to a series of digital messages," cautioned Chester Rindfuss of Boeing Computer Services. "It is an attempt to make machines think like people instead of forcing people to think like machines."

This capacity of computers is the one that frightens anyone who has read science fiction writers' visions of a future in which people are subservient to their machines. "This can never happen," stated Rindfuss, "because machines will never be able to do or know more than humans tell them. We can, however, look to computers to eliminate some of the drudgery of human life by asking them to do more than just process facts."

Small, fast, cheap, capable—this is the technological stuff of which educational visions are made. For education, technology provides a means to these ends:

- A school system which links home to school as well as to office and factory.
- The emphasis of teaching and learning shifting from mere absorption of information to learning how to learn.
- The drudgery of necessary drill work taken over by computers, revitalizing teachers to do the kinds of teaching that are more professionally and personally rewarding.
- Teachers managing the instruction of school-age and lifelong learners, working on varied lessons in different places at different times.
- Every student linked to teachers and databanks via telecommunications.
- The teacher shortage solved, both by rearranging the patterns of student-teacher contact and by creating a work environment for teachers attractive to bright youngsters who want to pursue a career in education.

EDUCATION'S FUTURE IS LINKED TO ECONOMIC CHOICES

"The future doesn't just happen, however," stated professional futurist Chris Dede, "it happens as a result of choices we make. Nor is what happens in the real world simply or always what is technologically possible."

To illustrate, Dede painted three potential scenarios, each setting a path for very different kinds of education systems:

Superindustrial Economy

Today, many folks look at our showing in the global economy and want technology to make the United States competitive again by driving down labor costs. Proponents of superindustrialization would argue that this could best be accomplished by eliminating the need for human workers in many jobs, instead using automated manufacturing and production processes, including robotics. Thus, productivity and efficiency would supersede the human gratifications traditionally derived from work such as job satisfaction and self-esteem.

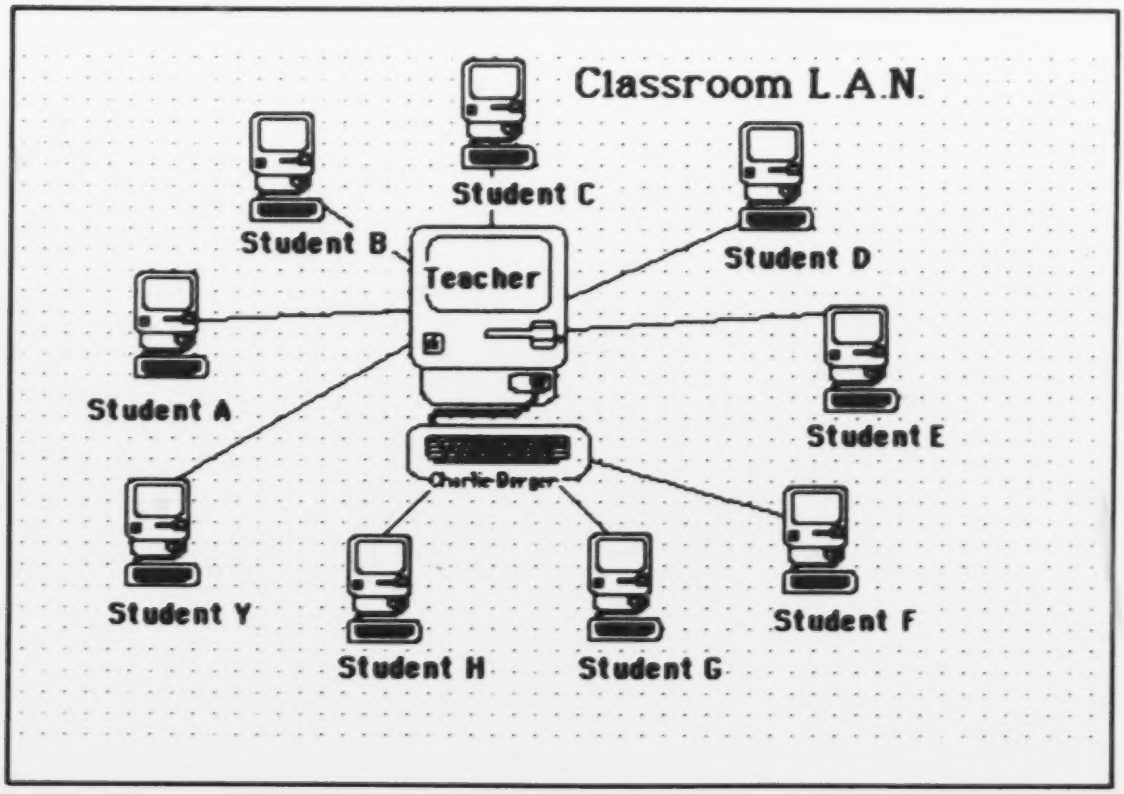
The Great Britain Economy

Some see the United States in decline, and would content themselves minimizing losses, as England has tried to do in recent decades. Muddling through, proponents of such an economic model would choose to change our traditional institutions (including education) but little, instead exalting past strengths that may or may not be applicable today and in the future "until, in 20 or 30 years, we too will really have dug ourselves into a hole."

Knowledge-Based Economy

This vision sees human workers in partnership with intelligent tools. The goal is not only to increase productivity and efficiency (as in visions of a superindustrial economy) but to also increase the workers' quality of life.

Dede contrasted such a knowledge-based trend in today's workplace with an example of superindustrialization. The latter is seen in the life of the supermarket checker, who uses an optical scanner to read product bar graphs: work gets done but life becomes more routine and regimented. Compare that scenario to today's secretary who exercises higher cognitive skills when the typewriter is replaced by the personal computer or word processor.



Clearly a knowledge-based economy and society will best serve America's principles and ideals; democracies do not function well on ignorance.

School boards are in the unique position of assuring that such a future can become reality by the choices that they make about education.

Education for members of a knowledge-based society, Dede stated, will require schools to give an entirely new definition to human intelligence. It is not memorization; for we have machines that help us to remember. It is not reading and writing only; for we have machines with spelling checkers and grammar checkers that speed the elementary language functions. Rather, the education system will have to emphasize the ability of people to do what computer-based tools cannot.

And so, "intelligence" will be redefined to include such skills as the ability to make decisions when only incomplete information is available, creativity, complex pattern recognition, synthesis and holistic thinking. "In a knowledge-based economy, these skills, traditionally associated with the liberal arts, are in fact vocational skills," said the futurist.

CAVEATS ABOUT TECHNOLOGICAL BELLS AND WHISTLES

There were many voices of caution about technology, at INFOMART'S INDEX: EDUCATION.

"I don't want to run down the contents of a building like this one with its dazzling displays of lights and wires and screens and printers and discs and lasers," Turner Educational Services executive Gary Rowe said of INFOMART. "I don't want to run down this shrine to silicon, but I do want to lift up a few doubts about our topic of conversation."

Rowe, whose corporation sells videotaped supplementary curriculum materials to schools for classroom use, said, "If there is a bandwagon racing into the micro'd, laser'd, silicon'd future, we're not ready to jump on it. All the high tech devices notwithstanding, schools are low-tech institutions. People tell us that the most effective communication tool besides the teacher is still the blackboard. Our position is to accept these realities of the classroom, as educators have described them to us."

Echoing Rowe was Dan Kunz of Commodore Computers (and a member of the Secretary's Task Force on Technology and Education): "The challenge before us is not that 'technology's here; let's get with it. The challenge is how can we use what's here. Technology may have all the bells and whistles, but can we really transfer its capabilities to education?"

"We can transfer technology's capabilities to education," responded Richard Byrne, "but only within the context of educational goals. First, however, we need to specify what we want to accomplish, because the measures of productivity are not obvious. Schools are not like athletic competitions, where a high jumper either clears the bar or knocks it off. In education, we must specify goals, then adopt the best technologies to achieve them."

Another stumbling block in getting technology into schools: it's far from perfected. Even at INFOMART, the audiovisual equipment sometimes failed, and the satellite link for the teleconference—which brought members of the Secretary's Task Force on Education and Technology to Dallas from Los Angeles—malfunctioned. At such embarrassing moments, it seemed that Murphy's Law was written for educational uses of technology.

In addition, there are software problems. Not enough is available, some participants said. Others complained about quality. Yet others decried the incompatibility of existing hardware and

software. Admonishing the industry for its "trade secret orientation," Gordon Stulberg, president of Polygram Corporation and a member of the Secretary's Task Force on Technology and Education, urged it to become more market-oriented.

Prodded to say when Commodore might take a lead in this direction, perhaps making its computers compatible with Apple's, Dan Kunz responded: "As soon as you can take your transmission out of your GM car and put it in your Toyota, you'll have compatibility in hardware and software."

Bemoaned one school administrator, "I feel caught in a high tech war for corporate supremacy."

Chris Dede cited other potential future problems that educators should take into account as they plan, including:

The Possible Human Cost

"We have to realize that using computers for drill takes time away from interacting with people—and that's the only way to learn affective skills, such as self-expression, the ability to evaluate yourself and others, and self-motivation.

Equal Access

There may be information haves and have-nots because the distribution of powerful tools will not be even at first.

Uniformity

The dollar cost of creating the technological tools that will make a knowledge-based future a reality is so vast that it will take a nationwide effort, "and that means that one curriculum for all may result."

Staff Resistance

Reallocating the percentage of school budgets now devoted to instructional materials and equipment (one percent) and staff compensation (85 percent) may offer one solution; but teachers and other staff members who feel underpaid are not likely to embrace this solution.

Lack of Consensus

According to Byrne, "Fears and beliefs are powerful disincentives to change anything." You may find getting agreement among people on the who, what, why, when and where of transferring technology to education may preclude its effective application.

Problems and caveats notwithstanding, some farsighted school officials are forging ahead. They not only believe that the tools of the information age can improve teaching and learning, they're actually demonstrating how it can be done.

PART II:

THE FUTURE IS NOW

Today, there are about 40 million children in 15,600 public school districts that employ about 3.5 million adults at an annual cost of $120 billion. Despite this investment, many school children are not convinced school is worth their time, many staff members feel underpaid and unable to respond to pressures to do more, and the taxpaying public is wary of increases in the public education price tag.

Notwithstanding these discouraging conditions, many educators remain sanguine about the opportunities offered by technological advances. They believe, used imaginatively and well, technology can enhance teachers' capacity to teach, administrators' capacity to lead and students' opportunities to learn.

During INDEX: EDUCATION, many problems facing public education which lend themselves to technological solutions were discussed. (See Part I of this report.) Today, embryonic versions of some of these solutions are being tested or are already in place in individual school districts across the nation. Yet others are proposed. This section reviews a few of those districts using technology to achieve their educational as well as administrative goals, and educational technology projects showcased during INDEX: EDUCATION.

NOT MAGIC, JUST POWERFUL TOOLS

Even as they expressed pride in their efforts to adapt and integrate technology into the schools, educators and researchers attending the conference were quick to disavow that technology is any magic cure. War stories abound about getting some of these new approaches into operation. Rather, they stress, technology should be viewed as a tool kit—one that can enhance the learning process, conserve scarce resources, and increase the impact of teachers on learning.

"The only way we'll reform education is to bring technology to the classroom teacher," declared Superintendent Arvid Nelson of Illinois' Indian Springs School District #109. Nelson has pioneered a district-wide network of classroom computers to put data at teachers' and administrators' fingertips as well as computer-based instruction in students' hands. (See Part III of this report.)

Others stressed that technology is shaping students' world, and if students are to cope with the dizzying changes in society, schools must contribute to students' ability to feel comfortable using technology.

"We look at computer competency as the foundation," said Donna Cooper, computer coordinator of the Clint (Texas) Independent School District, which incorporates computers into the curriculum from kindergarten through the 12th grade. "It's our responsibility to get our students ready to compete in the real world."

FROM PROBLEMS TO OPPORTUNITIES

The very problems which schools face—changing demographics, society's demand for excellence, the projected teacher shortage, the need to teach critical thinking skills—could also be an opportunity.

How might this happen? School budgets are labor-intensive. Nearly 85 percent of a school district's budget is expended on staff salaries and

COMPUTERS IMPROVE WRITING SKILLS

After the Province of Ontario made grants available for schools to purchase 12,000 computers, all with integrated word processing, an interesting phenomenon was noted.

Says Loren Smith of the Canadian Educational Ministry, when girls become involved in creative writing, they continued to do it in pencil, pen, on paper, only turning to the computer to key in the finest draft at the end.

Boys, "who can't write worth a dam anyhow (referring to the physical process)," went right to the computer and got started. They generally can't spell well, so they used the computer's spelling checker.

The result has been that the complexity of the boys' writing has improved immensely, Smith said.

fringe benefits. This isn't likely to change. But technology can help relieve the burden of non-instructional duties from school teachers and free them for the job they most want to do—teach.

According to Saul Rockman of Far West Educational Research and Development Laboratory (FWREL) in San Francisco, this is particularly applicable in the teaching of science, a subject area in which the shortage of teachers is acute and where the quality of teaching is often inadequate.

"Instructional technology can (and must) provide experiences that can't be provided better through other means," he said. "Technology can bring to classrooms crisp accurate imagery including magnification and time-lapse photography, to facilitate science experiences that otherwise could not be offered."

Moreover, he continued, students can observe harmful things and perform the safe computer-based equivalent of dangerous experiments with no risk involved. And students can "reach the unreachable" through technology's unique ability to capture events distant in space and time, and recreate them as desired.

By engaging students with computers and interactive video in lieu of some conventional laboratory experiments, expensive supplies can be allocated more wisely and students can log more lab time. Furthermore, it would allow handicapped students, many of whom are restricted by the physical setup of a conventional laboratory, to participate with their peers within a laboratory setting.

THE POTENTIAL OF SCI-LAB

Rockman described for INDEX: EDUCATION a bold project now being proposed to the National Science Foundation that would use interactive video to address both the shortage of science teachers and the need for increased science instruction. Known as "SCI-LAB," this project now in the planning stages by the National School Boards Association, FWREL, California State University and others, would use a mix of technologies to create a new kind of learning experience for students, one that would enable science teachers to instruct many more students than conventional laboratories now allow. SCI-LAB would consist of 60 instructional units—20 each in biology, chemistry and physics.

The purchase of interactive video equipment to use this SCI-LAB material would cost a school district roughly the same per-learning-station as it costs today to build a "wet lab." By intermixing SCI-LAB with wet lab facilities, a school using SCI-LAB would be able to expand greatly the range of learning experiences it offers students. SCI-LAB software would enable an instructor to manage a classroom of 25 to 30 students, each of whom may be working on a different stage of an experiment or even on different experiments. Gifted students and those with learning problems could readily be accommodated within the same classroom setting more easily than in conventional classrooms. Handicapped students who cannot work readily in conventional laboratories also would benefit from the interactive video equivalent.

In settings where there are small numbers of students, as in rural districts where laboratories are often inadequate and physics offerings nonexistent, students would have available the same science opportunities as students from larger districts. One or two teachers could handle a broad science curriculum in laboratory sciences. Whether or not the National Science Foundation funds this project, it is notable; of major importance to educators is that the concept illustrates how a new technology can make possible more efficient, productive and creative ways of schooling.

Although a concept originally developed for the sciences, the same technology that makes SCI-LAB feasible could easily be adapted in other curriculum areas such as the teaching of history.

COMPUTERS AND HIGHER ORDER THINKING SKILLS

HOTS—the Higher Order Thinking Skills project—is a present day example of how technology can address both diverse populations and equity. Says Stanley Pogrow of the University of Arizona's College of Education and developer of the HOTS project, "The challenge to education in the information age literally is to make kids smarter."

Schools must recognize, he stressed, that a large segment of the population, such as Chapter I students and others who traditionally might have sought jobs in factories following high school graduation, are going to be left high and dry if education doesn't find a way to help them learn, and to master higher level skills.

Throughout the remainder of the 1980s and during the 1990s, computers and robots are expected to continue to take over manufacturing jobs, both skilled and unskilled. Increasingly, word processing will diminish the need for clerical and secretarial help.

It's a "travesty," declared Donald M. Clark of Rockwell International, that kids aren't being trained for what society will need: 25 percent highly trained technocrats (at the masters and doctoral

MOVE OVER FLOPPY DISCS

"In the beginning, there was a book. Now there's a compact disc." That's how Kathy Hurley of Grolier Electronic Publishing Company introduced what has been called the greatest thing since the Guttenberg press: the compact optical storage disc that houses the 21-volume Academic American encyclopedia with room to spare.

In fact, the storage capacity of the CD/ROM, or Compact Disc/Read Only Memory, is so vast that it could store nearly five entire sets of the Grolier encyclopedia on its 4¼-inch iridescent surface.

Widespread acceptance of this new technology is inevitable, according to Hurley, because of its vast superiority to the more common magnetic or floppy disc. CD/ROMs are inexpensive, unbelievably indestructible and easy to store—in comparison to floppy discs which are fragile and must be handled with care.

More attributes: CD/ROMs have a storage capacity 1,000 times that of most floppy discs. And because international standards exist for this technology, any computer disc can be used by any brand of compact disc player.

On the other hand, as its name implies, the CD/ROM has no random access memory; like a phonograph record, you cannot add to its contents. That capability to modify the disc's contents, called Direct Read and Write (DRAW), is available today at very high costs and will be within schools' reach in a few years.

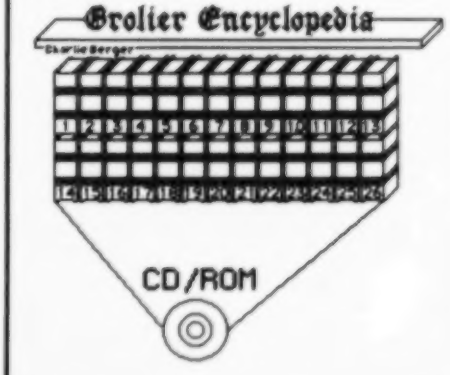
An illustration of CD/ROM's greatest fascination, for anyone who ever did a report by searching for information in the encyclopedia—and had a hard time finding it—is the utilization by the Grolier Electronic Publishing Company of this new information resource.

Users of Grolier's Academic American Encyclopedia on compact disc can search for any word and receive a listing of every single article in which that word appears. If a subject has no specific listing, it takes but seconds to access every article where it conceivably might be mentioned.

Moreover, since the encyclopedia's text requires only 20 percent of the space on the compact disc, there is ample room left for a word processing program, a thesaurus and a spelling checker. Preparation of reports would be facilitated with ease.

Sears-type catalogs, huge archives of financial or medical records, talking encyclopedias, fingerprint systems and complex programs for industrial robots all are examples of information systems that readily could be saved and easily accessed in the CD/ROM format.

CD/ROM, concluded Hurley, will penetrate the educational market far more quickly than have any of the other new technologies.



levels) and 75 percent highly skilled support staff.

Pogrow noted, "We're raising a generation of youngsters who will never have a chance to get the better paying jobs because they were never intellectually challenged."

He fears that most of them will fall into the "McDonald's Syndrome"—forced to take low-paying service jobs because they weren't educated for anything better, or because educators assume they couldn't be educated for anything better.

"What a tragedy it will be if these kids are really quite bright," he said, explaining why the decision was made by the HOTS project to work with Chapter I students, youngsters for whom the equity issue—access to educational opportunities that will prepare them for the real world—is a very significant one.

"Yet what do we expect of Chapter I kids?" he asked rhetorically. "Just get them up to grade level." But grade level may not be enough to avoid the McDonald's Syndrome: "We're underchallenging kids."

And so the HOTS program was born. Utilized this year in some two dozen school districts across the country, HOTS incorporates today's computers and available software along with different kinds of teaching behavior. There is no drill and practice and, said Pogrow wryly, no philosophical dependence on Bloom's Taxonomy. Entirely new teaching techniques were developed, techniques that force students to work independently to make decisions. "It's a thinking lab that happens to have computers in it."

"The principal difference between good thinkers and bad is that the bad thinkers stopped developing new strategies for solving problems at about the second or third grade. In their long-term memory, they don't utilize very sophisticated linkages, they don't see connections between ideas and facts.

"So we developed an information processing model of thinking that taught them how to use information to develop more sophisticated strategies and to improve their linkages." That is, HOTS is a strategy for teaching youngsters to think. "It works."

When the program was evaluated after the first year, the students "scored higher on every measure we had of thinking ability," continued Pogrow, compared to students in the control schools. On basic skills, the students had 14 to 15 percentile gains in reading, which accelerated even more the next year.

A bonus from HOTS, said Pogrow, addressing the concern of some educators about computers causing social isolation, was, "Our kids had 50 percent more new friends than those in the control group did."

MORE SUCCESSES WITH COGNITIVE SKILLS

Others described similar successes in teaching cognitive skills through computer use.

Barbara Bowen, applications grants director for the Apple Computer Corporation, and a member of the Secretary's Task Force on Education and Technology, noted that the Nation at Risk report was critical of schools' inability to teach abstraction, a high level of thinking.

Reseachers at MIT, she said, are studying how computers, through use of the programming language LOGO, can serve as a link between concrete material things and formal abstract systems. Thus, one aim is to use computers to enhance students' decisionmaking and problemsolving skills by focusing on the computer's ability to recognize non-obvious significant patterns and relationships within and among seemingly different types of data.

For example, nearly all youngsters can tap out a drumbeat pattern. A computer can display for the student a graphic picture of this pattern; the student then can see on-screen a depiction of an abstract system of music notes; and finally the student can see a mathematical system of numbers that represents the picture.

Work also is being done with LOGO and a children's favorite, Lego blocks. Children use the special geometry of LOGO known as "turtle geometry" to design and to plan structures they later can build with the Lego blocks. They also write LOGO programs that control the physical operation of moveable structures built from Lego blocks.

The use of Lego blocks in this university-based project underscores an important point in the analysis of how and why to use instructional technology in schools. Kids **like** Lego blocks, and kids **like** computers and all the trappings of the technological age.

Stanley Pogrow of the HOTS project said the decision to use computers was an easy one: "We had begun to see data that said kids see computers as private friends; teachers, as public enemies."

"I don't care how good your curriculum is, you can't teach higher level thinking skills if you can't get kids to think about what you want them to think about. The computer, after all, is captivating. Kids love it."

Houston superintendent Billy Reagan, noting that learning reaches a peak in the middle school grades for many youngsters, and then the bottom falls out, said that today's kids are different from earlier generations, and different from many of today's adults. The plain fact is most teachers cannot maintain the attention span of this, the first TV-immersed generation of students. He believes that successful schools will substitute the screen for the workbook to capture students' fascination with video. Teachers, he suggested, are going to have to adjust and teacher training is the key.

One reason teachers have a difficult time reaching students, according to Gordon Stulberg of the Polygram Corporation, is simply that they grew up in a linear age while students today learn in a visual mode.

DON'T NEGLECT TEACHER TRAINING

Some teachers share their students' fascination with technology. For them, the opportunity to shift some of the more boring aspects of teaching—drill and practice—to machines is a godsend. Those teachers, able to think of dozens of ways to use a computer or VCR as a resource, are the ones most likely to incorporate technology throughout the curriculum. Computers, video and other technology, used wisely, can allow a teacher far more time for the personal aspects of teaching. While technology may be a whiz at providing immediate visual reinforcement to students, it can't give a student a pat on the back.

But for the many teachers who don't take readily to the new technology, educators and computer experts emphasize that teacher training can-

not be neglected. Many teachers fear embarrassment when the 12-year-old computer whiz is the expert and the teacher is the novice. Moreover, as Clint, Texas, administrator Donna Cooper points out, it doesn't matter how great the technology could be, it won't go anywhere if you're sitting there trying to figure out how to turn it on.

That's why the major expense of IBM's "Electronic Schoolhouse" project was devoted to teacher training. In 1983, IBM gave millions of dollars in computers, software and technical assistance to several schools; Educational Testing Service (ETS) helped manage the project. (The Electronic Schoolhouse, an interpretive report of that experience by ETS's Martin Schneiderman and others, will be published by Earlburn Associates this year.)

Before schools in the project were permitted to use their new computer labs, teachers engaged in a two-week intensive training program, which began with such elementary tasks as teachers removing the computers from packing boxes, setting them up and learning to turn them on. These teachers in turn went back and conducted month-long teacher-training seminars with three to five teachers per school, who in turn returned to their assigned schools and conducted teacher development sessions for everyone else.

If he were beginning the project again, Schneiderman said, more involvement would be sought from building administrators. When administrators were not involved in the training and planning, barriers to effective use of the computers often occurred.

One conclusion: teacher training has to include helping teachers to incorporate the computers into the curriculum. As one novice teacher put it, "I've never worked harder. This is not a labor-saving device if I have to create my own materials and worry about some kid who just erased his files and figure out how all this can be made relevant to my subject."

Selecting the right software will ease that concern, as will training in classroom management techniques that incorporate how to integrate computer use and/or instruction into the learning process.

WRITING TO READ WINS OVER TULSA

One school district whose teachers are sold on the advantages of computers in the classroom is Tulsa, Oklahoma, where 25 elementary schools last year instituted IBM's Writing to Read program in kindergarten with resounding success, so much so that nearly all of the 69 elementaries have opted to use it this year.

According to superintendent Larry Zenke, Writing to Read was adopted in response to a growing insistence on the part of parents that kindergarten offer youngsters more than just an extension of the pre-school experience.

Developed by John Henry Martin, the program has been tested by more than 22,000 students in 250 schools. Using a personal computer, the children learn 30 words that contain 42 phonemes, combinations of letters that allow them to express every sound in the English language phonetically.

Since it does not require them to spell correctly, students are able to write their own stories, read them to their peers, and print out copies to take home to mom and dad. For the students, said teacher Jo Anne Zenke, it's an exhilarating experience.

"You know it's successful when the bell has rung, it's time to go home, and the child has his coat sleeve on one arm and the other hand still punching away at the computer," she continued. "You know it's successful when they'd rather work on the computers and write stories during free play than play with toys."

In fact, asserted Zenke, "Computers are the most well-used toys in my kindergarten. That's exactly what the kids think of them."

Through the Writing to Read program, kindergarten students in Tulsa, seated at computer terminals with small stuffed dogs perched atop, regularly write lengthy, creative stories with little assistance from the teacher. This would be impossible in the traditional classroom, Jo Anne Zenke believes. "When a child uses a pencil, forming the letters is such a laborious process that you barely get four lines from him. With a computer, maybe you'll get 20 lines."

As with any program, however, it is only as good as the teacher who is using it. But the computer's speed, which allows immediate feedback, cannot be underestimated. "The computer can interact with a child 55 times in 15 minutes. I don't believe any of us can give a child that kind of reinforcement," stated Zenke.

TECHNOLOGY WON'T REPLACE TEACHERS

Experts are quick to point out that the excitement over the new technology does not in any sense imply that teachers will be replaced by machines.

The purpose of the technology, INDEX speakers declared again and again, is to assist the instructor, to support the teaching effort, to relieve the paperwork burden and to facilitate true individualized instruction for each and every student, thereby making school and the learning process that goes on there more attractive to students. What the computer cannot replace are the teacher's years of experience, personal skills and management of the educational process.

Bringing this point into sharp focus was Gary Rowe of Turner Educational Services, who stated that nothing can replace the teacher and the blackboard as the chief tools of communication in the classroom.

Rowe explained this philosophy within the context of Turner Educational Services' 60-hour-long Portrait of America series, a video resource that goes far beyond the conventional instructional television concept.

"Didactic uses of television guarantee that television will fail in the classroom," Rowe said. "Television programs aren't books, they cannot succeed as books and they cannot succeed with passive teaching in the classroom."

Moreover, they will not be able to succeed, Turner Educational Services believes, until teachers can circumvent the linear aspects of videotape and the time contraints of live broadcasting. The teacher has to be able to decide when and how to use television. The teacher has to be the director, the person to decide if a program should be viewed this day or next week, or whether a portion should be used or the entire program.

Most importantly, video in classrooms has to rise from the often mediocre level of programming that has earmarked too much of instructional television and has prompted teachers to relegate television to their storage closets rather than to use it as an exciting adjunct to the learning process.

Usually good television, unfortunately, is expensive television; and schools have not chosen to allocate scarce dollars to compete with the quality of imagery that students have come to expect from watching television in their homes.

What Turner and its partner Raintree Publishing have done is to take superb, hour-long programs first prepared for broadcast, then divide them into video segments, and develop an array of supportive materials including suggested lesson plans, comprehensive index systems and exercises for all grade levels.

For video to be successful in the classroom, Rowe said, "The teacher must find that using [it] is so helpful, so exciting, so successful that the TV screen and the tape machine become akin to the blackboard in importance." Video should exist in the classroom not to overcome the deficiencies there but as a way to revalue time and efficiency, and as a way to revalue the teacher.

"Good television does not begin with technology. Good television isn't recorded by the camera unless there is first a sensitivity to how to tell a story—in words, pictures and actions—dramatically, engagingly and effectively . . . . Good story telling is good communication, and it is an article of faith to me that good teaching is, most of all, good communication."

THE POWER OF INTERACTIVE VIDEODISC

A related technology, and one that has been embraced for many applications by both the military and the business community, is interactive video. A few products from several publishers will be available in this medium for schools this year. NSBA's proposed SCI-LAB project intends to exploit this technology to its fullest.

Interactive video blends all the powers of computers—all the computer-aided instruction capability, all the computer management capability—with the power of video. The interaction is between the student and the screen; the student controls the image on the screen to the extent that he can turn it on, turn it off, run it forward, run it back, try again and again and again if that's important, or skip through material if the student already knows it.

The first uses of interactive video have been to simulate real-life experiences in training situations where the cost of real training is costly because of problems with replacing expensive and/or dangerous capital equipment, or in situations potentially dangerous to trainees and participants.

For example, it is very difficult to train people to fly airplanes on and off military carriers because airplanes are very expensive, as is the investment in pilot training. The interactive video system provides a simulation experience where pilots-to-be undergo the very real situation of being in a plane, perhaps dealing with weather changes or equipment failures and even, if appropriate, crashing procedures—without hurting themselves or equipment.

A number of companies, among them Digital Equipment Corporation, SONY, IBM, and NCR, have used interactive video technologies to develop management simulation games for in-house training purposes.

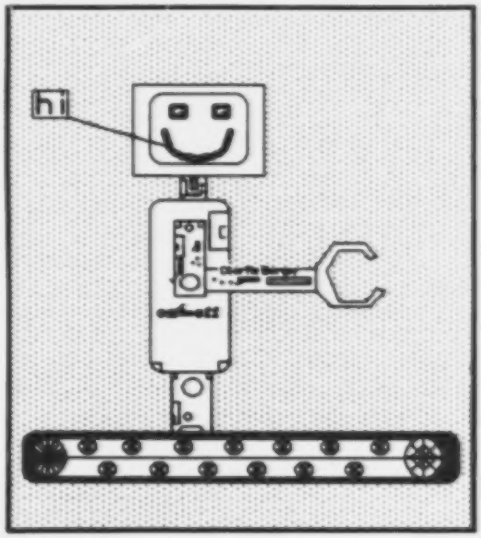
The capacity to enable students to interact in sophisticated ways with top quality media and instruction is here; but as with good television this capacity does not come inexpensively. The student learning situation with a videodisc player, a monitor, a touch screen and the computer capacity to make the whole system function costs at least $4,000 today. Far more expensive is the production end: the talented teams of people to design sophisticated instruction, to write scripts, to design software, to debug and test it, to do video, and to tie it all together.

Coincidentally, Rockwell's Donald Clark argued, that's why students must be equipped to live and to work in the technological age. The technology can be both a means for improving education and an end for students. Technology not only helps teach, it also opens doors to new and exciting career opportunities.

ROBOTS MAKE COMPUTER LITERACY FUN

When "RB" enters the classrooms at the Ysleta (Texas) Independent School district, students sit up and pay attention. They even try to sit on top of RB. Or ask him to play a few of his favorite tunes, guess how far away they're standing, or wriggle like a snake. If he asks them to count backward from 10, or fill in the blank in a statement like "Night is the opposite of_____," they squeal with delight and comply with haste.

RB, you see, is a robot, and the Ysleta schools have 10 of these friendly units to teach computer literacy.



"To us, computer literacy means the sum total of a person's experience with technology," explains John Primozich, a Ysleta instructor, "and robots are perhaps the most efficient—as well as the most fun—way we've found for kids to gain that experience." He lists five reasons for the children's attraction to the robots:

1. They're a powerful way to increase student awareness of all the technology around them today.
2. Because the robots can be programmed to do what you want, students are enthusiastic about learning programming skills. Students often program RB with instructions to go out the door, down the hall, into another room, and spin around and whistle before returning to the homeroom.
3. Those programming skills give students control of their environment in a way that the traditional classroom rarely does. Instead of sitting for six hours doing things directed by a teacher, they have an opportunity to give some directions when they program RB.
4. RB is a machine, and students know it, but they care for it with great affection, which Primozich says can help develop a sense of responsibility for others.
5. Finally, because of the children's active participation in directing RB, they respect what it takes to accomplish complex tasks.

Built by Rio Grande Robotics in El Paso, RB comes in kit form ($2,400) or completely assembled (slightly more). For $15 more, schools can get the "carnival barker" chip. Insert it in RB and hear him announce—and see him ape—his favorite circus animals. The grand finale, "Step right up . . . see the fantastic robot . . . bow, turn . . ."

PART III:

HARNESSING THE PROMISE

Computers are everywhere; we'd better do something.

When all the hoopla is over and the dust has settled, the message for educators about the new technology is twofold:

1. It's powerful, but don't move too fast to adopt the technology.
2. Adopt a studied and reflective approach to the purchase of technology's power.

This section presents practical tips on adopting the right policies, purchasing the hardware, evaluating the software, encouraging teachers and locating the funds needed to implement a technology plan for your school district. Many of these have been used by actual school districts and found to work; not ignored are a few of the programs that didn't work so you can avoid making someone else's mistakes.

DON'T IGNORE THE PROCESS

The process of purchasing the new technology is a long, involved one, if you want to do it right, state Marybeth Darrow and Joseph Little, microtechnology consultants.

According to Darrow and Little, the purchasing process begins with long-range planning which, in turn, begins with an advisory committee on technology which reports to the school board. The committee should be kept to a manageable size, preferably 10 to 15 individuals. Also important, Darrow recommends, is attaining cross-sectional representation on the committee from both the district and the school community, including both computer beginners and experts alike.

Second, make sure the committee has the resources (and the money, if necessary) to do its job properly. This means providing resources for visits to other school districts, to visit dealers, to attend workshops and to have access to the latest research and trade publications concerning technology and its applications in the schools. "If you want all the answers, you have to pay the freight," Darrow noted.

Next is a district-wide needs assessment, after which the committee can make recommendations to the school board for action. Central to this process is investigating and evaluating the current and future needs of the school district by surveying staff members, students, and the community. It is vital, according to Darrow, that philosophical considerations such as general computer literacy versus in-depth exposure for students as well as technical issues such as whether the district will use stand-alone computer systems versus local area computer networks be addressed by the committee.

Drawing on her experience implementing computer systems in school districts, most recently in Juneau, Alaska, Darrow insists that for technology systems to work the instructional staff must be sold on them. Otherwise, the technology is doomed to failure.

Many teachers are terrified of computer laboratories, Darrow said, because they are certain they can never manage one terminal, much less 30 of them. Power struggles also come into play. If one individual is particularly skilled at using computers, he or she might resent others attempting to schedule computer time in the laboratory.

For example, when computer labs, which included telecommunications equipment, were installed in schools participating in the $8 million "Electronic Schoolhouse" project, an interesting phenomenon was observed, according to Schoolhouse author Martin Schneiderman of the Educational Testing Service.

Said Schneiderman: "I've come to realize the telephone is the symbol of power in a school," explaining that personnel in some schools made it very difficult for project participants to have access to the telephone that was needed for communicating between schools in the project.

There is also concern about security factors, such as whether students (as in the movie WARGAMES) might be able to break into the school's database or even into government files and where liability would rest if they did.

ADOPTING POLICIES

Appropriate board policies are one way to address many of these concerns.

Microtechnology consultant, Joseph Little, suggested these points when considering policy needs:

- Whose equipment is it anyway? Once a computer sits in someone's classroom, he often considers it to be his. One possible policy: Equipment purchased by or donated to the district is district equipment.

- Who may use it? What happens when an outside group wants to borrow the school computer, or a staff member wants it for the weekend? One possible policy: During school hours, computers will be used primarily for instructional purposes. After hours, administrators and teachers may use the computers. When not used for school purposes, community organizations may borrow the computers within guidelines set by the administration.

- Who is responsible for the equipment? When equipment breaks down, no matter who is using it, who pays for it? If it is stolen or lost, who pays? One possible policy: All equipment owned by the school district will be properly insured, maintained and inventoried. Software will be referenced in—and checked out—through the school library.

- Why are we using computers? Is the school district's goal to teach computer literacy to all students or to ensure employment opportunities in technical fields or to teach higher level thinking skills? One possible policy: The board's educational philosophy statement should identify the instructional goals of the educational technology program.

- How can we buy the right equipment? One possible policy on machinery: No equipment will be bought before it has met established district criteria and been tested. Purchased equipment will be properly inventoried and tagged. One possible policy on software: No software will be purchased unless it has received at least two favorable reviews by district staff or in national magazines. In addition, it must supplement, not supplant, school curriculum.

- Is our computer program okay? One possible evaluation policy: Set measurable goals, allot adequate funding for equipment and materials to meet those goals, and conduct periodic evaluations of the computer program.

- What about copies? You believe students might make unauthorized software copies; some staff members may do it too. One possible policy statement: The board assures that technology use will be monitored to ensure that neither students nor staff infringe on copyrighted software rights. The board does approve of making one archival copy for backup purposes.

FINDING MACHINERY SUITABLE FOR YOUR DISTRICT

"If educators around the world would band together and demand machinery and software specifically designed for their needs, not for business or industry, they would get it," said Loren Smith of the Canadian Educational Ministry. "Schools have tremendous buying power, but first educators have to decide what they want."

Having just gone through a process of helping to establish specifications for Ontario schools, Smith suggested educators should demand machines and programs that allow children to use computers creatively in writing, composing, designing, analyzing and other extensions of original thought.

Computer literacy, per se, has little value as a subject, he believes. "Start the students using the computers and they'll automatically become literate."

Houston Superintendent Billy Reagan agrees that schools should band together and take advantage of the computer industry's competitive factor. He believes educators should all get together, district by district, state by state, and write educational specifications for the industry; then lease the equipment they need for their schools and say, "Industry, if you make this obsolete in three years, you can have it back."

A case in point: When vendors in Canada were told what the schools wanted, the initial response was, "you're kidding." But the educational ministry wasn't kidding at all: Some 12,000 computers are to be placed in Ontario's 65,000 classrooms this year, supplementing the many personal computers already there. Only one vendor met the ministry's specifications but one was enough.

Here's what Ontario asked for . . . and received:

- state-of-the-art 16/32 bit processors;
- safety and ergonomic features (e.g., tilting keyboards to adapt to different size students);
- bilingual capabilities;
- programming languages: Waterloo MicroBASIC, Waterloo MicroPascal and LOGO;
- UNIX-like operating system;
- pointing device user interface (similar to an upside-down mouse. The kids love using it, and it eliminates the need for keyboard skills.);
- local area networks (for individualized instruction, although Smith notes that some teachers defeat the purpose of the LAN by having all 30 terminals on the exact same lesson.);
- disc standards;
- voice synthesis;
- service requirements;
- Canadian content (60 percent hardware, 98 percent software); and
- integrated word processing.

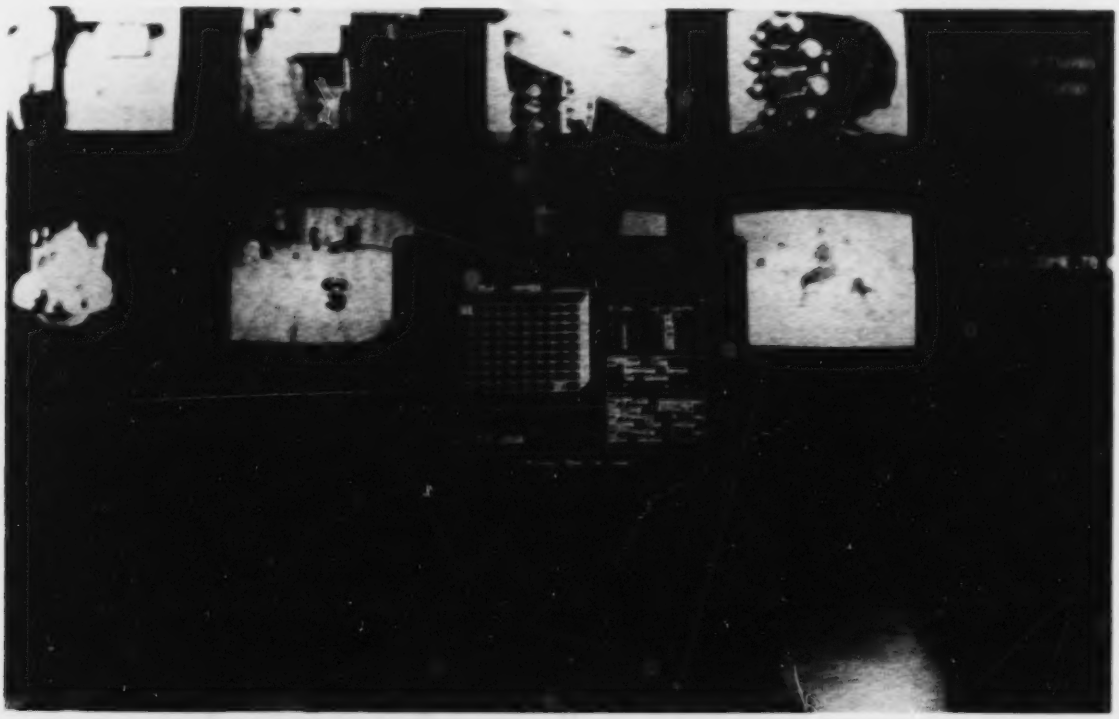
SOFTWARE: SORTING THE BAD FROM THE GOOD

Selecting software is an even more awesome task than selecting computer equipment. The good news is that there is so much of it; the bad news is that so much of it is poor. For software is useless, no matter how exciting it might seem or how well it has been evaluated, if it doesn't fit into the curriculum.

Dallas superintendent Linus Wright points out that 7,000 pieces of educational software are now available, with hundreds of new pieces being developed every month. Yet according to School Tech News, a magazine published by Education News Service, only 113 educational software packages received high evaluation grades from three or more of the leading evaluation services.

Agreeing that curriculum is the key, consultant Bruce Gjertsen cautioned schools to be aware of "hidden" agendas in the software review process that can undermine purchasing decisions, such as hostility to the program or fear of being shown up in front of students.

"Have you ever seen a person approach a bank machine, try to figure out how to use it, not be



able to and finally leave in frustration and disgust?" Gjersten asked. "That's a failure, even though it might be the best software in the world."

When trying to evaluate software, consider these points:

- Who are the reviewers?
- What experience have they had with the subject matter?
- What experience have they had with the targeted student population?
- How many students have used this software? And under what conditions?
- How were the ratings determined?
- How many reviewers were used?

Recommended as a starting point for software selection is Evaluation of Educational Software: A Guide to Guides, which outlines the processes necessary for making an informed choice and offers several evaluation models. Information on a wide variety of print and organizational resources is included. The guide is available from the ERIC Document Reproduction Service, P.O. Box 190, Arlington, Virginia 22210.

WHEN THE BILLS COME—ONE DISTRICT'S STORY

When the purchase of learning materials constitutes only one percent of the average school district's budget, the cost of technology may loom as a prohibitive factor.

There are grants available and arrangements can be made with vendors to finance a district's computer purchases, but the Garland (Texas) Independent School District decided to secure its computer system by passing a bond.

The district started by doing its homework thoroughly. After determining in 1982 that the technology available on the market could have a positive impact on the Garland schools, Superintendent Eli Douglas appointed a task force to investigate the district's computer needs as well as the funding needed to achieve that goal.

Seven full months were consumed by the committee's work. Consequently, a thoroughly researched report complete with the task force's recommendations was sent to the board for action before a campaign to convince the public of the need for a computer program was even begun. "What they didn't want was a cosmetic computer lab," Douglas said of the committee's recommendations.

Months were devoted to researching what kind of computers would best meet the needs of Garland's 30,000 students. The district experimented first with personal computers but quickly ran out of appropriate software. Eventually the decision was made to go with the Hydra system—which contains a large library of software—from Plato/Wicat Systems. To pay for the computers, $7 million of a $69 million bond issue, passed by a 6-to-1 margin in 1983, was set in reserve to underwrite computer acquisitions.

"The cost," said Douglas, "is very reasonable once you've put out the initial outlay (because of the district's increasing tax base, taxes were not raised to pay for the computer system). In fact, our CAI (computer-aided instruction) is the most cost-efficient of our systems."

When the costs were figured, it was estimated that putting in a computer lab (with 30 terminals and a host computer) was more or less similar to putting in a library, a cafeteria or a science lab. Costs for the computer lab, inclusive, averaged $6.51 per student. By comparison an elementary school library for a building of about 600 students had a cost factor of nearly $50 per student, Douglas noted.

The district started with 45 labs, and will add 30 more this year with an additional 20 planned for the near future. Each high school has seven dedicated, subject-specific labs that can handle up to 600 students a day, with careful planning.

The administration of the district is fully automated as well. All 57 district facilities are connected to a mainframe with every office and every secretary's desk electronically connected.

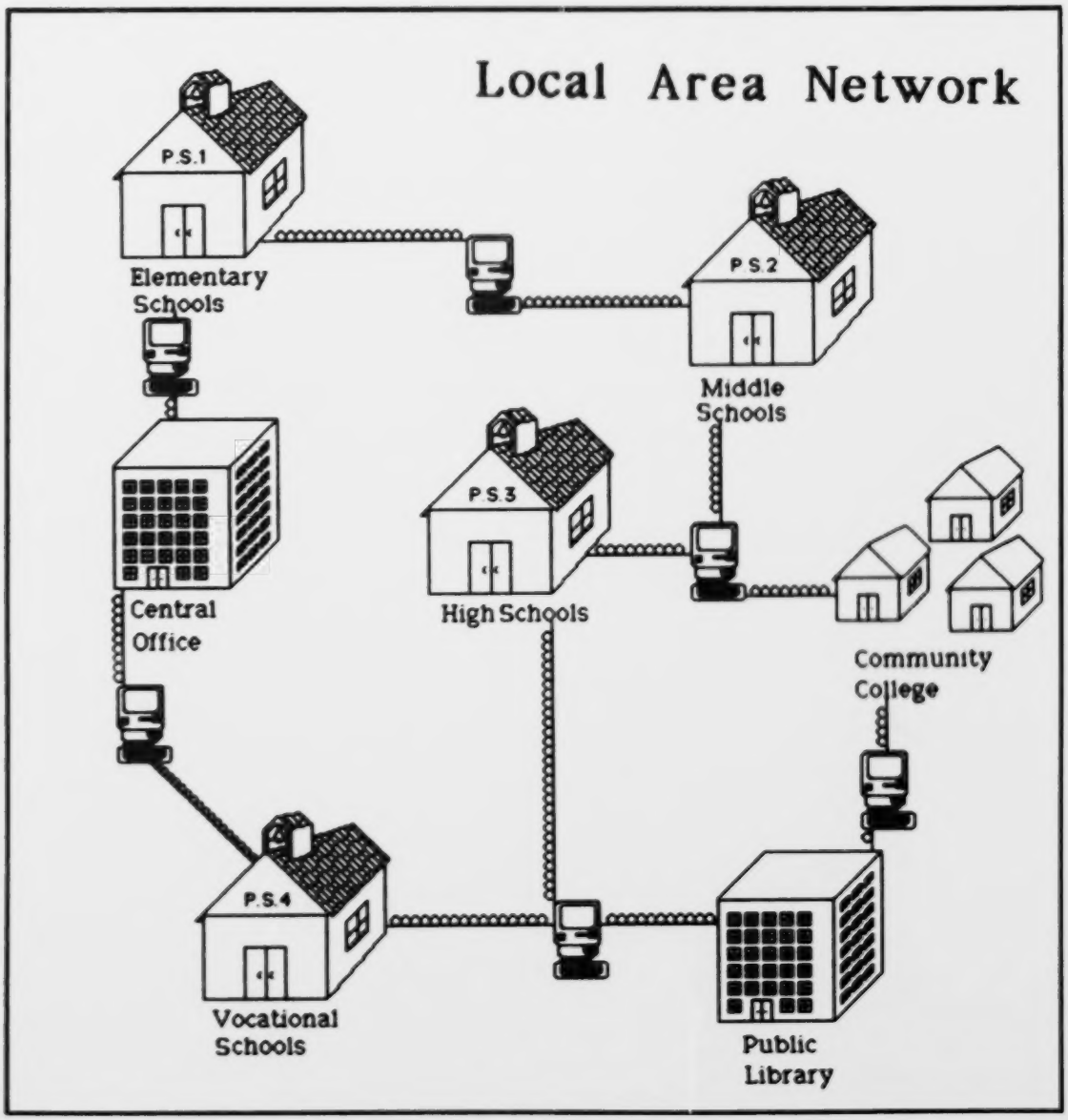
Concluded Douglas: "We're heading toward a paperless society in our school district."

THE ULTIMATE PAPERLESS DISTRICT?

While the Garland schools are working toward a fully implemented network of computer-assisted instruction as well as administrative management, one small school district not far from Chicago's Midway Airport is already there.

Consider, if you will, what these problem situations share in common:

- A parent calls up to ask why Johnny's reading grade is slipping.
- A teacher wonders what percentage of the school budget is allocated for supplies this year.
- You and a school principal work away from your desks, need to talk, but spend a good part of each day playing "telephone tag."



Answer: They all have a common solution—one that libraries have developed to a far greater extent than schools—a local area network or LAN.

A network of computers, LANs vary in size and complexity depending upon the users. A LAN may tie together work stations in a single room, or all the rooms on one floor, or all the floors in one building, or all the buildings on one campus, or even home-based employees.

Imagine the superintendent who can call up Johnny's reading record on his desktop personal computer, see where he is assigned, whether he is pulled out of regular classes for special attention, where his parents work, what his health record is, and more.

Picture a teacher tapping into the central office financial records and reviewing budget allocations that will help him plan his program.

Think about the ease of leaving a message on the personal computer (PC) of that peripatetic principal who when he returns to his office will check his "electronic bulletin board."

Those are just some of the LAN capabilities now in place in Superintendent Arvid Nelson's Indian Springs School District #109 in Illinois.

"Back in 1979, we thought we were really on the move. We wondered how much further we could go," said Nelson as he described the district's entree into the computer field. The big move consisted of sending a principal to programming school, calling him a director of computer services, and buying one 32K computer which couldn't print and be programmed simultaneously.

Since then, Indian Springs has upgraded its system several times, installed computers in every principal's office, created a teacher training program that its sponsor, IBM, brags about around the world, and entered every bit of data from every student's basic record into the central office computer. A telecommunications link allows authorized users to call up any student's record, the school budget, personnel records, or attendance reports.

Nelson's district, not especially wealthy, got a lot of help from corporate friends, especially IBM, as well as from the federal government.

"Our halls are often busy with electricians bringing the system up to new capabilities," said Nelson, who this fall will see computer links in every classroom. "Our goal, ultimately, is to have an individual education plan for every single one of our 2,400 kids. We started with central office records first, because I believed I had to have my house in order before extending the networks to principals, then teachers, and finally students." A goal for the not-too-distant future is to make it possible for parents to be linked to the schools through personal computers and telecommunications.

"We're a very labor-intensive industry, and a paper-intensive industry. We're working on becoming a paperless district within the near future," said Nelson.

Soon there will be an optical scanner (a computer device that "reads" a printed page) in every Indian Springs school. Teachers will be able to insert graded reading tests under a scanner that will convert the image into electric impulses and send them straight into the student's central office records. The teacher's grade book could go the way of the stylus and the copybook.

"It's like moving from the icebox to the refrigerator age. Secretaries no longer type up every form, report card test score, test, workbook, newsletter or newspaper release. It's all in the computer: we just print it on our laser printer."

Noting that schools now spend 80 to 85 percent of their budgets on staff salaries and fringe benefits, Nelson believes computers are a way to reform education by reallocating funding percentages in the typical school budget. "All states have reform movements," Nelson said, "but the only way to reform education is to allow teachers to spend more time in the affective domain, working with kids, instead of recordkeeping and other paperwork. The public schools will have to work closer with business and industry, because technology will reform education."

WHERE TO TRAIN TEACHERS

There's no end to where people can learn about the new technologies, advised Saul Rockman of the Far West Educational Laboratory. Nor apparently is there a limit on the depth or variety of coursework available. Classes are available to fit anyone's personal goals, whether it is to secure another degree, develop professionally, or earn a salary increase. The incentive to sign up for any and/or all of these courses is the starting point for most educators who want to look for ways to "engage youngsters' imaginations" or to make management operations more efficient. Among the sources of training:

- State education departments
- State or private colleges and universities
- Intermediate education agencies
- School districts
- Vendors

What they offer:

- Simple awareness programs for beginners ("where's the off/on button?")
- Seminars on how to select resource materials, pick teaching strategies
- Software evaluation techniques
- How to write individual education plans for handicapped students
- Programming skills, languages
- Problem solving, higher order thinking skills
- Such computer applications as creating spreadsheets
- Instructional design
- How to fix your computer
- Telecommunications
- More efficient classroom management
- Automation of school administration tasks such as attendance reporting, class scheduling, and so on.

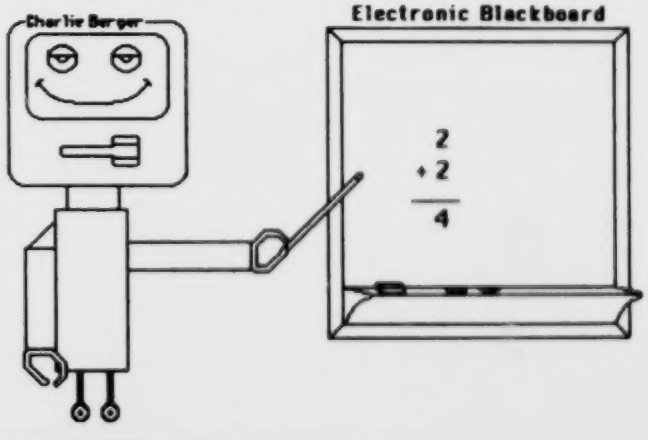
AVAILABLE HARDWARE

If technology's tools possess properties and attributes desirable and affordable to educators and learners, eventually they will be adopted, said Christopher Dede of the University of Houston/ Clear Lake.

Several decades may pass before the full capabilities of some of these devices are realized, but, for school districts that are still weighing the technological options, Dede listed the following technologies that will be (or already are) available by the end of the 1980s at a cost comparable to human instruction:

TECHNOLOGY — APPLICATION

- Hand-held Computers:
  - --drill and practice work
  - --presentation of simple materials
  - --responses to student-initiated questions on a specific topic
  - --simple games to build basic skills (such as spelling)
- Microcomputers:
  - --complex games to build higher order thinking skills (such as advanced math)
  - --simple interactive simulations (such as lab experiments)
  - --simple "microworlds" (e.g. what would happen if gravity behaved differently)
  - --voice input and output
  - --spreadsheets (for planning and management)
  - --computer art and music; sophisticated graphics
  - --word processing
  - --authoring programs (enabling teachers to create instructional packages)
  - --computer-managed instruction
  - --information management, recordkeeping and data retrieval
- Large Computers:
  - --complex simulations and microworlds
  - --complex presentation of databases (e.g. a three-dimensional tour through the Animal Kingdom)
  - --sophisticated electronic library
- Computer Networks:
  - --electronic mail
  - --inexpensive transfer of large programs or databases
  - --computer conferencing
- Mass Telecommunications:
  - --instructional delivery in extra-school settings
  - --dramatic learner experiences (to increase student motivation and retention)
  - --simple models of skilled performance (e.g. cooking)
- Videodiscs:
  - --complex models of skilled performance (e.g. carburetor repair)
  - --surrogate travel (perhaps a trip through an art museum with the student controlling the speed of the tour)



NAME THOSE TOOLS

What are some of the new technological tools? One caveat: Don't get hung up on the terminology; the names keep changing as new tools, new uses, new manufacturers and new configurations arise. Below is a quick overview of some of the new and existing technologies.

Computers? Yes, of course. Computers come in various sizes and capacities, including micro- or personal computers, hand-held portable computers, robots (computers with moving parts), mainframes and mini-computers. To help people communicate with computers are typewriter-like keyboards, mouses, touch screens, graphics tablets and other devices. The above items in conjunction with peripheral (plug-in) devices turn computers into music, graphics, administrative, printing and publication, simulation and communications machines as well as much more.

Computers can be used singly in a classroom; or they can be clustered and/or linked in various ways called "networks" or "local area networks" (LANs). However, computers are just part of the new technologies.

There are also:

Video And the sound (audio) that accompanies the pictures. Grouped as "telecommunications" are all the ways to bring sounds, words, pictures and motion from anywhere to anywhere, including cable, satellites, microwave, slow-scan technology, teleconferencing and more. The devices you need to do this, such as cameras, modems, telephones, or electronic chalkboards, combine in many ways. One such combination of computers and video widely used today in corporate, military and medical teaching is called "interactive video." Some people call it "intelligent videodisc." By whatever name, it is coming to schools this year.

Devices for storing data—whether for pictures, words or sounds— come in many varieties of tape and disc formats and more are coming, each new one seemingly cheaper, more durable, more compact, more flexible or more powerful than the last. So-called floppy discs and hard disc drives as well as audiotapes and videotapes are based on magnets. Optical discs, videodiscs and compact discs are based on laser technology. One laser records data on the disc, a metal plate encased in plastic; another laser reads the data.

The most exciting disc technology this year, it seems, is the compact disc or CD/ROM (Compact Disc/Read Only Memory) because its 5 1/4-inch size, durability, convenience, storage capacity and its low manufacturing costs make it readily useful in homes and schools, and as cheap as books and phonograph records.

These instructions—regardless of the physical format in which they reside—are called "software." Computer software has to be written so

Software This array of devices from computers to robots disc drives works according to instructions.

that the machines can respond to the instructions. Because English (or French or Swahili) won't do, computer instructions are written in such programming languages as COBOL, PASCAL, BASIC or LISP. Literature to explain how to develop and/or make use of the software is called "documentation."

Sometimes software is built into the machines; sometimes it comes on tapes or discs. In many cases, software is pre-packaged; or you can create your own, which is called "programming."

CONCLUSION

Historically, America's public schools have been a productive servant to the nation. The educational system has helped produced a citizenry supportive of the nation's ideals, a workforce among the most educated in the world, and leaders in government, business, technology, science, and medicine as well as a host of other disciplines.

Admittedly the nation's schools are far from perfect, and their improvement has been a constant desire throughout the century. And, today it is no different. If the nation is to aspire for a great future, one that builds on its successes and the wealth of past achievements, its schools must teach the next generation to be more productive thinkers, citizens, leaders and workers than ever given the complexities of the global economy in which we now live.

Wise applications of technology may be the key to more productive schools. School boards, because of their unique policy role in charting the course of education for the future, can help to harness the power of new technology for public education.

With the creation of its Institute for the Transfer of Technology to Education, NSBA has pledged to help school boards and state school boards associations explore the alternatives that seem best to them. Some response must be made to technology's "knocking at the schoolhouse door," said NSBA Executive Director Thomas A. Shannon. "School officials cannot sit back and wait until the tidal waves of demand crest."

SHANNON: "SCHOOL BOARDS MUST LEAD THE WAY"

The wise use of technology to make schools more productive is a "top-down phenomenon," according to NSBA Executive Director Thomas A. Shannon. "The school board and superintendent must initiate the program and persist in its support."

Shannon's four-point program for success:

1. Comprehensive policy collection. Calling policies "a critical element in the success of [computer] programs." Shannon recommends clear guidelines on equitable access, personnel training, facilities availability, security, proper environmental controls for optimal equipment functioning, and hardware and software purchasing criteria.

2. Expert administrative leadership. "Assigning a school administrator who is not a computer technology expert is a grave error," says Shannon, who notes that "inept advocacy on the part of the non-computer-expert administrator" can cause "the whole computer effort [to] take it on the chin."

3. Adequate salary incentives. School boards that want effective computer programs have to put some money behind the effort, said Shannon. He recommended two financial incentives: reimbursement for computer training courses, and differential placement on the school salary schedule for computer experts.

4. Adequate staff training. Leadership in a computer training program is more risk-oriented than traditional school administration, according to Shannon, but he adds, "Stand-pattism—waiting for new developments always just around the corner—won't do." Sympathizing with disheartened school officials who've found they spent "lots of money in June for stuff that is not 'state-of-the-art' in September," Shannon recommends that administrators not only teach themselves about computer applications, but also work with coalitions of leaders from other districts to make purchasing decisions about hardware and software.

GLOSSARY

ARTIFICIAL INTELLIGENCE (AI)—Refers to efforts to use computers so that they act in ways similar to humans, such as making judgments.

BASIC—An acronym for Beginners All-Purpose Symbolic Instructional Code. BASIC is a computer programming language, commonly used in public schools.

BIT—The smallest unit of data recognized by a computer. "Bit" is an abbreviation for binary digit. A bit has only two values—0 or 1. All computer data are expressed entirely in combinations of bits. (See also BYTE.)

BLOOM'S TAXONOMY—A widely used list of the relative difficulty and relationships between different types of learning and thinking developed by University of Chicago professor Benjamin Bloom.

BYTE—Fundamental measurement of computer memory storage. A byte is equal to approximately 8 bits. By analogy, think of bytes as words, bits as letters.

CAI—Computer-aided or computer-assisted instruction. CAI usually refers to those uses of computers in the teaching process where the computer is made to act as a tutor leading a student through a learning task. Sometimes, CAI is used more broadly to include virtually any use of computers in a school's instructional program.

CHIP—See SILICON CHIP.

CMI—Computer-managed instruction. If a computer acts as a tutor with a student, that is CAI. If the computer keeps a record of what the student does and reports all the interaction to the teacher, or if the computer analyzes the student's work and "decides" what the student should tackle next, that is CMI.

COMPACT DISC (CD)—Refers to a small disc onto which data are recorded and retrieved by use of a laser. A CD can store lots of data; for example, a 21-volume encyclopedia fits on one-fifth of a compact disc.

COMPACT DISC/READ ONLY MEMORY (CD/ROM)—CD/ROM is a compact disc from which the user can retrieve information or data, but cannot modify its content. (See also ROM.)

COMPUTER—A general term for a machine that performs high-speed manipulations of data or information using a pre-written set of instructions, known as software.

CRT—A cathode ray tube. CRT is the most common type of computer screen; also known as the picture tube in most television sets.

DATABASE—A large collection of organized data. For example, all the phone numbers in a city or all key historic events since 1878. In conjunction with a category of software, known as database management systems (DBMS), computers are used to compile databases as well as to analyze and manipulate them.

DISC—A flat, circular device used for storing data. Discs come in various sizes and storage capacities. Sometimes the word is spelled "disk."

ELECTRONIC CHALKBOARD—A device that enables one to write on a chalkboard-like surface, and receive the image on a computer screen or in paper copy. Connected to a telecommunications system, it can be used to teach students at remote locations.

GRAPHICS TABLET—An attachment to a computer that allows you to draw on a tablet and have a copy of that image appear on a computer screen.

HARDWARE—The physical equipment that comprises any computer system, for example the computer screen or printer, distinct from software.

HOST COMPUTER—A central computer that has other computers linked to it for data transfer and retrieval. Like a good hostess or host, it runs the party.

INDEX: EDUCATION—INFOMART, the trademart in Dallas for the information technology industry, conducts five large annual meetings, one of which is INDEX: EDUCATION. INDEX is an abbreviation of INformation and Data EXchange.

INTERACTIVE VIDEO— Also known as intelligent videodisc. It refers to several ways in which computers and video can be linked together. Usually the imagery from both a computer and a video source (tape or disc) are displayed on the same screen. A ten-year old medium, it is a powerful teaching device, especially for instruction that requires simulations.

KEYBOARDING—Entering data into a computer or data storage device using a typewriter-like keyboard.

LOCAL AREA NETWORK (LAN)—Two or more computers linked to each other in close proximity, such as an office or classroom, are called a Local Area Network. The term also refers to devices and software that connect the computers and make the arrangement work.

LOGO—A computer programming language frequently used in primary schools. Designed by professor Seymour Papert at MIT, its goal is to help people, especially young people, understand mathematical relationships.

MAGNETIC BUBBLE—A new computer chip that enables storage of more data in less space within a computer.

MAINFRAME—A large computer, with lots of processing speed and power. The term is used to differentiate between large computers, minicomputers and microcomputers.

MEMORY—Similar to human memory, computer memory is an area where instructions for a computer function are stored. When a computer or device is said to have some amount of memory such as 64K, K stands for kilobytes (1,024 bytes).

MICROWAVE—A type of radio wave used in certain long-distance communications systems.

MODEM—An acronym for MOdulator-DEModulator. It is a device that enables remote communications between computer systems by linking them to one another over telephone lines.

MONITOR—The screen in a computer or video system.

MOUSE—A computer attachment for pointing and drawing. It rolls on a flat surface and allows the user to communicate with the computer. The term "mouse" comes from the two little buttons on top that resemble ears and a long cord that resembles a tail. For example, when you roll a mouse on a flat surface, you may create a line on the computer screen in an identical pattern to the path of the mouse.

NETWORK—See LOCAL AREA NETWORK.

OPTICAL SCANNER—A device that scans (reads) text, pictures or numbers and electronically translates them into data that can be understood by the computer. A common type of optical scanner is the product bar code reader found in supermarkets.

OPTICAL STORAGE—Any system for data storage that uses light beams (lasers, usually) to record and read data. CDs and videodiscs are two optical storage devices.

PASCAL—A computer programming language which rivals BASIC's popularity in schools for teaching students to program computers.

PERIPHERAL—Any device that can be attached to a computer, such as a printer, monitor or modem.

PERSONAL COMPUTER (PC)—A microcomputer, generally thought to be suitable for home, office or school use.

PRINTER—A device that translates data from a computer or video onto paper.

RAM—An acronym for Random Access Memory. It is computer memory that you can modify at will, and move around to suit your computing needs.

ROBOT—A device with some computer components that can do mechanical work such as lifting and carrying. Some people think of robots as machines to do mechanistic human tasks.

ROM—An acronym for Read Only Memory. It cannot be changed because it is permanently built into a computer or other device during the manufacturing process.

SILICON CHIP—A minute piece of semiconductor material containing a complete computer microprocessor.

SIMULATION—The use of computers, video and other devices to duplicate real situations. Airplane pilot training or complex mock-ups of nuclear reactors used to teach employees how to cope during a disaster are dramatic examples of simulation. Computer simulation is used most commonly in situations where it is too costly or potentially dangerous to conduct training in real situations.

SLOW-SCAN TV—A special television system for inexpensive long-distance communications when the quality of the TV image is not critical.

SOFTWARE—The electronic instructions that cause a computer or other electronic devices to function in a particular manner.

STORAGE—There are two types of computer storage: primary and secondary. Primary storage refers to ROM or RAM, the internal computer memory or storage capacity required to process software instructions. Secondary storage refers to either the disc storage devices such as drives, cassettes or audiotapes or to the data storage capacity of such devices. See also MEMORY.

TECHNOCRATS—Derived from the word bureaucrat, it refers to highly trained individuals in such fields as computer science, engineering, and mathematics; or to the bureaucrats in organizations where scientists and engineers work.

TELECOMMUNICATIONS—Refers to the vast array of systems for communicating over long distances and the industries that use or produce these systems including telephones, computer modems, and satellites.

TELECONFERENCING—The ability to hold meetings between groups of people over long-distances using such mediums as the telephone, video (television images) or computer.

TERMINAL—A CRT-like device usually with a keyboard that is used to access and display information stored on a computer. Some terminals known as "intelligent terminals" have the ability to modify the information accessed.

TOUCH SCREEN—A computer attachment that is placed over a computer screen to create the illusion that by touching the screen at designated points, you are communicating with a computer. Like the mouse, scanner or graphics tablet, the touch screen is designed to allow you to communicate with a computer without using the keyboard.

TRACK—The channels on tapes or discs, similar to phonograph record grooves, in which data are stored.

VIDEOCASSETTE RECORDER (VCR)—A machine for recording data on magnetic tape. Commonly used for recording television programs on cassette tape, a VCR can be used to store any kind of data.

VIDEODISC—An optical storage device that is used mostly for visual imagery. It can also be used to store sound as well as data.

WORD PROCESSING—Refers both to software or a special type of computer or machine that allows you to "process" words: write, erase, rephrase, edit, punctuate, and organize text.

APPENDIX

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IN MEMORIAM

This publication is dedicated to the memory of Paul A. Salmon, immediate past executive director of the American Association of School Administrators. A life-long friend of education, Dr. Salmon was en route to Dallas to address the first annual meeting of NSBA's Institute for the Transfer of Technology to Education when the airplane on which he was travelling crashed. He planned to share his personal experiences using technology to improve schools—a subject that for many years had captured his attention and, through his enthusiasm, inspired others.

ABOUT NSBA

The National School Boards Association is located in the Washington, D.C., metropolitan area in colonial Alexandria, Virginia. NSBA is a not-for-profit organization whose primary mission is the general advancement of education through the unique North American tradition of local citizen control. In this way, public elementary and secondary school policy is decided by local school board members, who are accountable to the community either directly (97 percent are elected) or indirectly through appointment by elected officials. NSBA promotes the betterment of the public elementary and secondary schools through services to state school boards associations and local school boards; by maintaining liaison with other education organizations and governmental authorities; and by increasing school board effect on federal education laws and regulations, and in court cases relating to education.

Federation members of NSBA are the 49 state school boards associations, the Hawaii State Board of Education, plus the boards of education in the District of Columbia and the Virgin Islands. About 2,000 local district school boards, which are members in good standing of their state associations, are NSBA Direct Affiliates.

NSBA represents the interests of school boards before congress; provides development programs for school board members; provides school district management services; and offers to the school board movement a variety of other services including the annual convention.

The NSBA Federal Relations Network, composed of up to three school board members in each congressional district, plays a major role in NSBA's education advocacy program in Washington, D.C.

The award-winning monthly magazine, The American School Board Journal, has been owned and published by NSBA since 1967. Publication of another monthly magazine, The Executive Educator, began in January 1979, and a fortnightly newspaper, School Board News, began in 1981.

Six special NSBA groups within the Federation play a significant role in the National School Boards Association's effort to serve Federation Members and school board needs:

- The NSBA Council of Urban Boards of Education focuses on serving the unique needs of urban school boards.
- The NSBA Large District Forum focuses on the unique needs of major non-urban school districts.
- The NSBA Rural District Forum serves the special needs of rural school board leaders.
- The Council of School Attorneys focuses on issues of school law.
- The Conference of School Boards Association Communicators serves NSBA and Federation Member communications professionals.
- The Forum of Federal Policy Coordinators focuses on the administration of federally-funded programs.

NSBA also maintains close liaison with other groups, including the National Caucus of Black School Board Members, National Caucus of Hispanic School Board Members, National Association of State Boards of Education (NASBE), American Association of School Administrators (AASA), the National Conference of State Legislatures (NCSL), U.S. Chamber of Commerce, Joint Council on Economic Education, and Education Commission of the States (ECS), to mention but a few nationwide organizations influencing education in the U.S.

Newly established NSBA services include the Institute for the Transfer of Technology to Education (ITTE), with a mission to harness the best of technology in behalf of public education, and the Center for State Legislation, School Law and Public Policy, which will provide expanded resources and information to state school boards associations and local boards.

NSBA represents the nation's 97,000 school board members who, in turn, represent the more than 40 million public school children in the U.S., which accounts for about 90 percent of all the elementary and secondary school students in the nation.

NSBA policy is determined by a 150-member delegate assembly composed of active school board members from across the country. Translating this policy into action programs is a board of directors consisting of 20 members and four ex officio members. The executive director administers NSBA programs, assisted by a professional staff.